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(30)Priority
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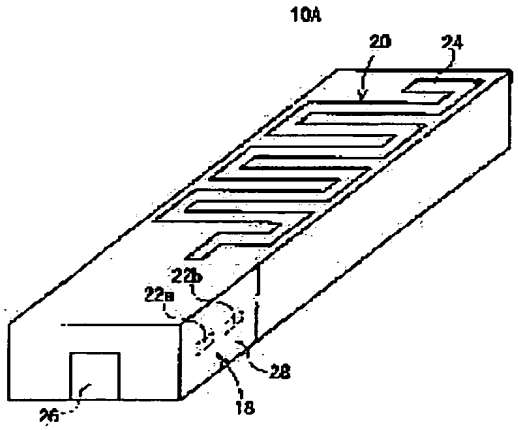
(54) ANTENNA SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To miniaturize an antenna system while avoiding gain reduction and narrow frequency band.
SOLUTION: An antenna section 20 and a filter section 18 are integrally formed on a dielectric board and the antenna section 20 and the filter section 18 are coupled via a capacitor to configure the antenna system 10A. In this case, a relation of $0.3 \times Lr \cdot Lt \cdot 1.2 \times Lr$ holds, where Lt is an antenna length of the antenna section 20 and Lr is an antenna length measured by the antenna single body.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Antenna equipment characterized by forming the antenna section and the filter section in one into a dielectric substrate, and combining the aforementioned antenna section and the filter section through capacity.
[Claim 2] Antenna equipment which sets the antenna length of the aforementioned antenna section to Lt, and is characterized by being 0.3xLr<=Lt<=1.2xLr in antenna equipment according to claim 1 when the antenna length when measuring with an antenna simple substance is set to Lr.
[Claim 3] Antenna equipment characterized by the antenna length Lt of the aforementioned antenna section being 0.6xLr<=Lt<=1.2xLr in antenna equipment according to claim 2.
[Claim 4] Antenna equipment characterized by the antenna length Lt of the aforementioned antenna section being 0.75xLr<=Lt<=Lr in antenna equipment according to claim 3.
[Claim 5] Antenna equipment characterized by the antenna which constitutes the aforementioned antenna section being a monopole antenna in antenna equipment given in any 1 term of claims 1-4.
[Claim 6] Antenna equipment characterized by the antenna which constitutes the aforementioned antenna section being an antenna which has a MIANDA line configuration in antenna equipment given in any 1 term of claims 1-4.
[Claim 7] Antenna equipment characterized by the antenna which constitutes the aforementioned antenna section being a helical-like antenna in antenna equipment given in any 1 term of claims 1-4.
[Claim 8] Antenna equipment characterized by the length of the resonator of the input side of the aforementioned filter section differing from the length of the resonator of an output side in antenna equipment given in any 1 term of claims 1-7.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the antenna equipment which formed the antenna pattern by the electrode layer in the dielectric base.
[0002]
[Description of the Prior Art] Many things which formed the antenna pattern by the electrode layer in the front face of a dielectric base from the former in order to attain the miniaturization of antenna equipment and the miniaturization of a transmitter are proposed (for example, refer to JP,10-41722,A, JP,9-162633,A, and JP,10-32413,A).
[0003] It can be used for a wiring substrate, mounting many of these antenna equipments in it directly, and this has become one of the advantages.
[0004]
[Problem(s) to be Solved by the Invention] However, in the antenna equipment in which the antenna pattern by the electrode layer was formed on the front face of a dielectric base, a fall and narrow-band-izing of gain will usually be caused with the miniaturization.
[0005] this invention was made in view of such a point, and though a fall and narrow-band-izing of gain are avoided, it aims at offering the antenna equipment which can attain a miniaturization.
[0006]
[Means for Solving the Problem] The antenna equipment concerning this invention forms the antenna section and the filter section in one into a dielectric substrate, combines the aforementioned antenna section and the filter section through capacity, and is constituted.
[0007] When unifying the antenna section and the filter section through capacity, antenna length is theoretically determined according to the center frequency of the filter section.
[0008] Moreover, since the size of the antenna section becomes dominant rather than the size of the filter section, as for the antenna equipment with which the antenna section and the filter section were unified, it is clear from on a gestalt that size's of this antenna equipment it is greatly dependent on antenna length (wavelength).
[0009] Furthermore, a miniaturization of an antenna knows that a fall and narrow-band-izing of gain will take place.
[0010] However, when the antenna section and the filter section were unified through capacity and antenna equipment was produced this time, even if it changed antenna length, not changing made the input impedance of antenna equipment clear.
[0011] From this, even if it shortens the antenna length of the antenna section, for example, the fall of gain can be suppressed to the minimum. Moreover, it is connected with the ability of the yield to be raised by adjusting antenna length by the manufacturing process that the input impedance of antenna equipment does not change even if it changes antenna length.
[0012] And in the aforementioned composition, when the antenna length of the aforementioned antenna section is set to Lt and the antenna length when measuring with an antenna simple substance is set to Lr, it is good also as $0.3xLr<=Lt<=1.2xLr$.
[0013] The range longer than the antenna length Lr in an antenna simple substance was included because it had the effect that the large margin of mass-production nature can be taken on a

design here since change of gain is small, even if antenna length changes, although the effect of a miniaturization fades the antenna length Lt of the antenna section like 1.2xLr.
[0014] It is desirable still more desirable that it is 0.6xLr<=Lt<=1.2xLr, and the antenna length Lt of the aforementioned antenna section is 0.75xLr<=Lt<=Lr.
[0015] And the antenna which constitutes the aforementioned antenna section may be a monopole antenna, and you may be the antenna which has a MIANDA line configuration. Moreover, you may be a helical-like antenna.
[0016] Moreover, you may make it the length of the resonator of the input side of the aforementioned filter section differ from the length of the resonator of an output side. The difference in the resonance frequency of each resonator in accordance with the mismatching of each impedance by the side of the external circuit of the filter section and the antenna section can be negated by this, and it can consider as the good filter section of a damping property. This leads to quality improvement of antenna equipment.
[0017]
[Embodiments of the Invention] Hereafter, the example of a gestalt of operation of the antenna equipment concerning this invention is explained, referring to drawing 1 - drawing 14 B.
[0018] Antenna equipment 10A concerning the gestalt of the 1st operation The filter section 18 to which the dielectric layer of the tabular of two or more sheets has the electrode 14 for I/O by the side of a circuit, and the electrode 16 (refer to drawing 2) for I/O by the side of an antenna in a laminating and the dielectric substrate 12 calcinated and constituted as shown in drawing 1 and drawing 2 , The antenna section 20 connected to the I/O electrode 16 by the side of the antenna of this filter section 18 through capacity is formed in one, and is constituted. By the following explanation, the electrode 14 for I/O by the side of a circuit is described as the 1st electrode 14 for I/O, and it describes the electrode 16 for I/O by the side of an antenna the 2nd electrode 16 for I/O.
[0019] The filter section 18 has the composition in which the 1/4-wave resonant elements 22a and 22b of two one end open sand molds were formed in parallel, respectively, and the antenna section 20 has the antenna 24 formed in the upper surface of the dielectric substrate 12 of the electrode layer at the MIANDA line configuration.
[0020] Moreover, in antenna equipment 10A concerning the gestalt of the 1st operation, as shown in drawing 1 and drawing 2 , the input/output terminal 26 connected to the 1st electrode 14 for I/O of the filter section 18 is formed, and the ground electrode 28 is formed in the portion corresponding to the filter section 18 at the right lateral and left lateral of the dielectric substrate 12, respectively.
[0021] Specifically, sequentially from the top, the 1st - the 10th dielectric layer S1-S10 are accumulated, and the aforementioned dielectric substrate 12 is constituted, as shown in drawing 2 . These [1st] - the 10th dielectric layer S1-S10 consist of layers of one sheet or two or more sheets.
[0022] The antenna section 20 and the filter section 18 are formed in the field to which it dissociated on the dielectric substrate 12 mutually superficially, and the antenna section 20 is formed in the upper surface of the 1st dielectric layer S1, and it is formed in the 10th dielectric layer S10 from the 3rd dielectric layer S3, applying the filter section 18.
[0023] And in antenna equipment 10A concerning the gestalt of the 1st operation, as shown in drawing 2 , two resonant elements (the 1st and 2nd resonant elements 22a and 22b) are formed in one principal plane of the 7th dielectric layer S7 in parallel, the edge of one way each was considered as opening, and each other-end section has connected these resonant elements 22a and 22b with the ground electrode 28 too hastily.
[0024] The electrode 16 for I/O of the above 2nd with which an end is connected with the electrode 14 for I/O of the above 1st by which an end is connected to an input/output terminal 26, and capacity coupling is carried out to 1st resonant-element 22a through the antenna section 20 and capacity, and capacity coupling of the other end is carried out to 2nd resonant-element 22b is formed in one principal plane of the 6th dielectric layer S6.
[0025] Each open end of two resonant elements 22a and 22b is countered, and two inner layer ground electrodes 30a and 30b are formed in one principal plane of the 5th dielectric layer S5,

respectively.
[0026] The inner layer ground electrode 32 connected to the ground electrode 28 of the lateral surface is formed in the portion corresponding to the filter section 18 among one principal planes of the 3rd dielectric layer S3.
[0027] The ground electrode 28 and the joint adjustment electrode 34 made into floating in potential to the input/output terminal 26 grade of the filter section 18 are formed in one principal plane of the dielectric layer S8 of the octavus.
[0028] This joint adjustment electrode 34 has the configuration to which 1st electrode main part 34a which counters 1st resonant-element 22a, and 2nd electrode main part 34b which counters 2nd resonant-element 22b were electrically connected by lead electrode 34c formed between them.
[0029] Each open end of two resonant elements 22a and 22b is countered, and two inner layer ground electrodes 36a and 36b are formed in one principal plane of 9th dielectric-layer S9, respectively.
[0030] And in antenna equipment 10A concerning the gestalt of the 1st operation, as shown in drawing 1 and drawing 2 , the electrode 38 for forming capacity between the 2nd electrode 16 for I/O and the end of an antenna 24 is formed in one principal plane of the 2nd dielectric layer S2. This electrode 38 and the 2nd electrode 16 for I/O are electrically connected through the through hole 40.
[0031] It explains referring to the representative circuit schematic of drawing 3 about an electric combination of each electrode in antenna equipment 10A which starts the gestalt of the 1st operation here.
[0032] Two resonators 50a and 50b by the 1st and 2nd resonant elements 22a and 22b are connected to parallel between an input/output terminal 26 and grounding, respectively, further, inductive coupling of resonator 50a and 50b which these-adjoin is carried out mutually, and, thereby, they serve as the form where the inductance L was inserted between adjoining resonator 50a and 50b, on an equal circuit.
[0033] Moreover, between 1st resonant-element 22a and the 2nd resonant-element 22b, the synthetic capacity C by the joint adjustment electrode 34 is formed, and it becomes the form where LC parallel resonant circuit by the inductance L and capacity C was connected, between each resonator 50a and 50b.
[0034] moreover, each open end of the 1st and 2nd resonant elements 22a and 22b and a corresponding inner layer ground electrode (30a, 36a) -- in between, capacity (synthetic capacity) C1 and C2 is formed with and (30b, 36b), respectively
[0035] Moreover, between 1st resonant-element 22a and an input/output terminal 26, electrostatic capacity C3 is formed through the 1st electrode 14 for I/O. Electrostatic capacity C4 is formed between the 2nd electrode 16 for I/O and 2nd resonant-element 22b which constitute Contact CN. Between Contact CN (2nd electrode 16 for I/O), and the antenna section 20, electrostatic capacity C5 is formed through an electrode 38, and electrostatic capacity C6 is formed between Contact CN (2nd electrode 16 for I/O), and grounding (ground electrode 32).
[0036] That is, the filter section 18 and the antenna section 20 are combined through capacity C5 (and C4), and antenna equipment 10A concerning the gestalt of the 1st operation has circuitry by which insertion connection of the impedance matching circuit 52 which consists of capacity 5 and C6 between the filter section 18 and the antenna section 20 especially was made. In addition, matching of an impedance can be made to realize also by changing the electrostatic capacity C1 and C2 which changed or shows the length of Resonators 50a and 50b to drawing 3 instead of electrostatic capacity C6.
[0037] And in antenna equipment 10A concerning the gestalt of the 1st operation, even if it changed the antenna length of the antenna section 20, not changing made clear the input impedance of antenna equipment 10A.
[0038] Even if this shortens the antenna length of the antenna section 20, for example, it can suppress the fall of gain to the minimum, and is connected with the ability of the yield to be raised by adjusting antenna length by the manufacturing process moreover.

[0039] One experiment was conducted in order to clarify the content of required antenna length in antenna equipment 10A concerning the gestalt of the 1st operation here. Hereafter, the example of an experiment is explained.
[0040] First, evaluation about the antenna simple substance 60 was performed with the measuring method shown in drawing 4 . As shown in drawing 4 , this measuring method drilled the hole 68 for letting the connector 66 of a network analyzer 64 pass in the center of the flat-surface square-like copper plate 62, and attached the antenna simple substance 60 (antenna length =L) of the measuring object in the dielectric substrate 70 which extends in the perpendicular direction of this connector 66. Length [of one side] m of a copper plate 62 carried out to 1.5 or more [of the wavelength in the inside of the vacuum of a test frequency].
[0041] And when changing the antenna length L of the antenna simple substance 60, it measured how center frequency would change using the network analyzer 64. The typical frequency characteristic of the antenna simple substance 60 is shown in drawing 5 , and change of the center frequency by the difference in the antenna length L is shown in drawing 6 .
[0042] As shown in drawing 5 , the antenna length L is determined that the smallest frequency of the amount of reflection will suit required frequency in a circuit in the usual RF circuit, i.e., the circuit where the antenna and the filter are not unified. If it does not do in this way, an antenna will be used in the large place of the amount of reflection, and it will become loss (loss that a sending signal does not get across to an antenna) of an output, and the cause of undesired oscillation so that clearly from drawing 5 .
[0043] On the other hand, in antenna equipment 10A concerning the gestalt of the 1st operation, even if the antenna length L changes, antenna gain (gain which shows the signal (output) of which was sent to the external world from the antenna) does not change.
[0044] This phenomenon is explained referring to drawing 7 and drawing 8 . In this example, center frequency of the filter section 18 is set to 2450MHz in antenna equipment 10A (refer to drawing 1 and drawing 2) concerning the gestalt of the 1st operation.
[0045] First, when the frequency characteristic is evaluated only with the antenna simple substance before unifying the filter section 18 and the antenna section 20, in order to set center frequency to 2450MHz, that it is necessary to make it 21mm made the antenna length L clear.
[0046] On the other hand, antenna gain was measured, changing the antenna length L, after unifying the filter section 18 and the antenna section 20. A measurement result is shown in drawing 7 . Moreover, the antenna gain in the passband (2400-2500MHz) of the filter section 18 in this antenna equipment 10A and the relation with the antenna length L were investigated. This result is shown in drawing 8 .
[0047] Although about 8dB gain degradation arose when the antenna length L was shortened from 21mm to 15.3mm with an antenna simple substance, even if it shortened the antenna length L of the antenna section 20 from 21mm to 15.3mm, in antenna equipment 10A concerning the gestalt of the 1st operation, it was only that about 3dB of gain deteriorates. Furthermore, even if shortened to 12.6mm, being stopped by 6dB made degradation of gain clear.
[0048] Thus, in antenna equipment 10A concerning the gestalt of the 1st operation, even if it shortens the antenna length L of the antenna section 20, for example, the fall of gain can be suppressed to the minimum. And since the antenna length L can be adjusted by the manufacturing process, the yield of antenna equipment 10 can be raised.
[0049] Although the above-mentioned example shows the case where the antenna 24 of the letter of meandering which has width of face smaller than the width of face of the dielectric substrate 12 is formed in the upper surface of the dielectric substrate 12 in addition, like antenna equipment 10Aa concerning the 1st modification shown in drawing 9 You may make it form the antenna 24 of the letter of meandering which has the almost same width of face as the width of face of the dielectric substrate 12, and may make it apply an antenna 24 to the both-sides side of the dielectric substrate 12 like antenna equipment 10Ab concerning the 2nd modification shown in drawing 10 . Moreover, although illustration is omitted, you may make it the shape of a simple strip of paper.
[0050] In an above-mentioned example, connection between 1st resonant-element 22a and an input/output terminal 26 Although it connects by capacity coupling through the 1st electrode 14

for I/O formed on the 6th dielectric layer S6 and connection between 2nd resonant-element 22b and an electrode 38 was connected by capacity coupling through the 2nd electrode 16 for I/O similarly formed on the 6th dielectric layer S6 In addition, composition as shown in drawing 11 is also employable (antenna equipment 10Ac concerning the 3rd modification).
[0051] Namely, antenna equipment 10Ac concerning this 3rd modification The ** which does not form the 1st and 2nd electrodes 14 and 16 for I/O on the 6th dielectric layer S6, The direct file of the connection between 1st resonant-element 22a and an input/output terminal 26 is carried out through the 1st electrode 80 for connection formed on the 7th dielectric layer S7. You may be made to carry out the direct file of the connection between 2nd resonant-element 22b and an electrode 38 through the 2nd electrode 82 for connection similarly formed on the 7th dielectric layer S7. In this case, large bandwidth can be taken. In addition, the equal circuit of antenna equipment 10Ac which starts this 3rd modification at drawing 12 is shown.
[0052] Next, it explains, referring to drawing 13 - drawing 14 B about antenna equipment 10B concerning the gestalt of the 2nd operation. In addition, a same sign is attached about drawing 2 and a corresponding thing, and the duplication explanation is omitted.
[0053] Although antenna equipment 10B concerning the gestalt of this 2nd operation has the almost same composition as antenna equipment 10A (refer to drawing 2) concerning the gestalt of the 1st operation mentioned above as shown in drawing 13 , the length of 1st resonant-element 22a of the input side of the filter section 18 differs from the length of 2nd resonant-element 22b of an output side.
[0054] Specifically, the length of 2nd resonant-element 22b is set up shorter than the length of 1st resonant-element 22a. An impedance as shown in drawing 3 , when this looks at left-hand side (input/output terminal 26 side) from Arrow A turns into a characteristic impedance (50ohms) of the external circuit connected to an input/output terminal 26, as shown in drawing 14 A. On the other hand, as the impedance which looked at right-hand side (antenna section 20 side) from Arrow B is shown in drawing 14 B, capacity C10 becomes equivalent to what was connected in parallel at a characteristic impedance (50ohms).
[0055] Since the above-mentioned capacity C10 is added in parallel with 2nd resonator 50b by 2nd resonant-element 22b, resonance frequency will differ with the 1st and 2nd resonators 50a and 50b. In order to compensate this, as shown in drawing 13 , the 1st and 2nd resonators 50a and 50b can be set as the same resonance frequency by making 2nd resonant-element 22b shorter than 1st resonant-element 22a.
[0056] Thus, it can set to antenna equipment 10B concerning the gestalt of the 2nd operation, the difference in the resonance frequency of each resonators 50a and 50b in accordance with the mismatching of each impedance by the side of the external circuit of the filter section 18 and the antenna section 20 can be negated, and it can consider as the good filter section 18 of a damping property. This leads to quality improvement of antenna equipment 10B.
[0057] Next, the manufacture method of the antenna equipments 10A and 10B concerning the gestalt of the 1st and the 2nd operation is explained. In the antenna equipments 10A and 10B concerning the gestalt of the 1st and the 2nd operation, since the interior (built-in) of the various electrodes is carried out into the dielectric substrate 12, as for these electrodes, it is desirable to use the low thing of specific resistance with little loss.
[0058] As a dielectric to be used, it is reliable and a latus thing, i.e., a ceramic dielectric, has the desirable width of face of selection of a dielectric constant. In this case, the miniaturization of each filter can be attained effectively.
[0059] moreover -- as the manufacture method -- the Plastic solid of ceramic powder -- a conductor -- after applying a paste and forming an electrode pattern, it is desirable to unite with a ceramic dielectric, where it carried out the laminating of each Plastic solid, and it calcinated further, it turned precisely and the laminating of the conductor is carried out to the interior
[0060] When using the conductor of Ag system or Cu system, the melting point of those conductors is low, and since it is difficult, carrying out simultaneous baking with the usual dielectric materials needs to use the dielectric materials which may be calcinated at low temperature rather than those melting points (1100 degrees C or less).
[0061] Moreover, dielectric materials which the temperature characteristic (temperature

coefficient) of the resonance frequency of the resonance circuit formed becomes [degree C] in **50 ppm /or less on the character of the device as a microwave filter are desirable.
[0062] As such dielectric materials, it is the end of a cordierite system glass powder, and TiO2, for example. Powder and Nd2 Ti 2O7 The thing of textile glass yarns, such as mixture with powder BaO-TiO2-Re2 O3-Bi 2O3 There are what added some glass formation component and the end of a glass powder to system composition (Re:rare earth component), and a thing which added the glass-powder end of some to barium-oxide-titanium oxide-oxidization neodium system dielectric MAG constituent powder.
[0063] as an example -- MgO(18wt%)-aluminum2 O3-(37wt%) SiO2(37wt%)-B-2 O3-(5wt%) TiO2 (3wt%) -- end of glass powder 73wt% of composition, and TiO2 of marketing Powder 17wt% and Nd2 Ti 2O7 Powder 10wt% is fully mixed and the end of mixed powder is obtained.
[0064] In addition, Nd2 Ti 2O7 Powder is Nd 2O3. Powder and TiO2 After carrying out temporary quenching of the powder at 1200 degrees C, what was ground and obtained was used.
[0065] And in the manufacture method of the antenna equipments 10A and 10B concerning the gestalt of the 1st and the 2nd operation, the solvent of an acrylic organic binder, a plasticizer, toluene, and an alcoholic system was added, and it fully mixed with the alumina ball in the aforementioned end of mixed powder, and considered as the slurry. And a green tape with a thickness of 0.2mm - 0.5mm is produced by the doctor blade method using this slurry.
[0066] next, the silver paste after carrying out stamping of the aforementioned green tape to a desired configuration -- a conductor -- it considers as a paste and the conductor pattern shown in drawing 1 and drawing 2 is printed, respectively, subsequently, after piling up and carrying out the laminating of the green tape required in order to adjust the thickness of the green tape by which these conductor patterns were printed so that it may become the structure of drawing 1 and drawing 2 in piles, it calcinates at 900 degrees C and the dielectric substrate 12 is produced
[0067] While printing the pattern of an antenna 24 on the upper surface of the dielectric substrate 12 constituted as mentioned above, the pattern of the ground electrode 28 was printed to the both-sides side of the dielectric substrate 12, and the these-printed pattern was printed on it at 850 degrees C.
[0068] By adopting the above manufacture method, the antenna equipment with which the filter section and the antenna section 16 were united with one by the dielectric substrate 12 through capacity is easily producible.
[0069] In addition, the antenna equipment concerning this invention of the ability of various composition to be taken is natural, without deviating not only from the gestalt of above-mentioned operation but from the summary of this invention.
[0070]
[Effect of the Invention] As explained above, even if it shortens the antenna length of the antenna section, for example, according to the antenna equipment concerning this invention, the fall of gain can be suppressed to the minimum. And since antenna length can be adjusted by the manufacturing process, the yield of antenna equipment can be raised.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective diagram showing the antenna equipment concerning the gestalt of the 1st operation.
[Drawing 2] It is the decomposition perspective diagram showing the antenna equipment concerning the gestalt of the 1st operation.
[Drawing 3] It is the representative circuit schematic showing the antenna equipment concerning the gestalt of the 1st operation.
[Drawing 4] It is explanatory drawing showing the measuring method of the frequency characteristic of an antenna simple substance.
[Drawing 5] It is drawing showing the typical frequency characteristic of an antenna simple substance.
[Drawing 6] It is the property view showing change of the center frequency by the difference in the antenna length of an antenna simple substance.
[Drawing 7] In the antenna equipment concerning the gestalt of the 1st operation, it is the property view showing change of the antenna gain when changing antenna length.
[Drawing 8] It is the property view showing the relation between the antenna gain in the passband (2400-2500MHz) of the filter section in the antenna equipment concerning the gestalt of the 1st operation, and antenna length.
[Drawing 9] It is the perspective diagram showing the antenna equipment concerning the 1st modification.
[Drawing 10] It is the perspective diagram showing the antenna equipment concerning the 2nd modification.
[Drawing 11] It is the decomposition perspective diagram showing the antenna equipment concerning the 3rd modification.
[Drawing 12] It is the representative circuit schematic showing the antenna equipment concerning the 3rd modification.
[Drawing 13] It is the decomposition perspective diagram showing the antenna equipment concerning the gestalt of the 2nd operation.
[Drawing 14] Drawing 14 A shows the impedance seen from Arrow A in the equal circuit of drawing 3 , and drawing 14 B shows the impedance seen from Arrow B in the equal circuit of drawing 3 .
[Description of Notations]
10A, 10Aa-10Ac, 10B -- Antenna equipment
12 -- Dielectric substrate 18 -- Filter section
20 -- Antenna section 22a -- The 1st resonant element
22b -- The 2nd resonant element 24 -- Antenna
26 -- Input/output terminal 28 -- Ground electrode
38 -- Electrode

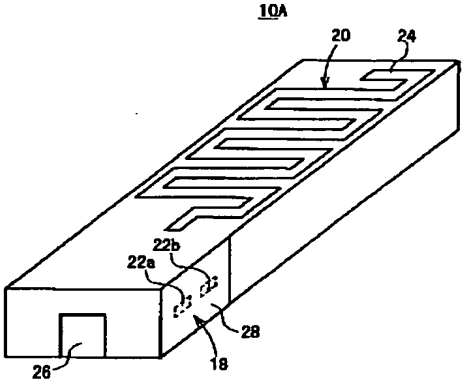
[Translation done.]

* NOTICES *

DRAWINGS

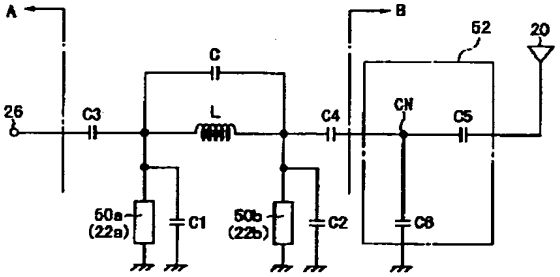
[Drawing 1]

FIG. 1



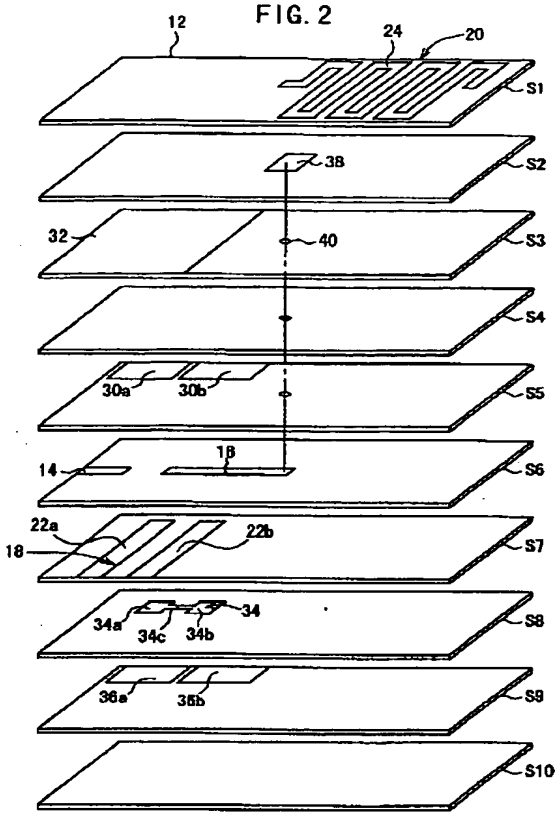
[Drawing 3]

FIG. 3



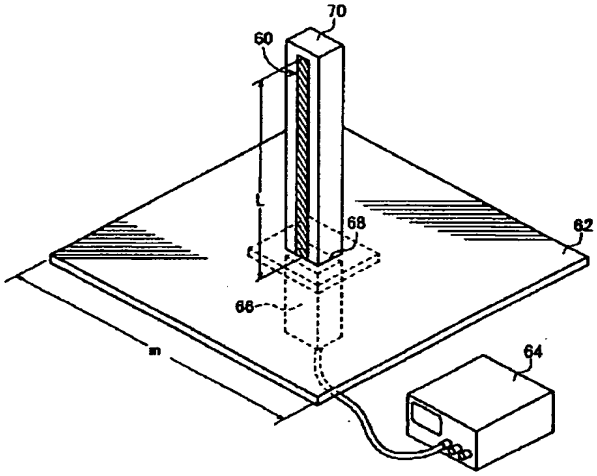
[Drawing 2]

FIG. 2



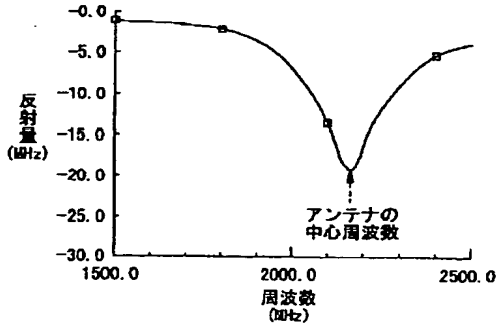
[Drawing 4]

FIG. 4



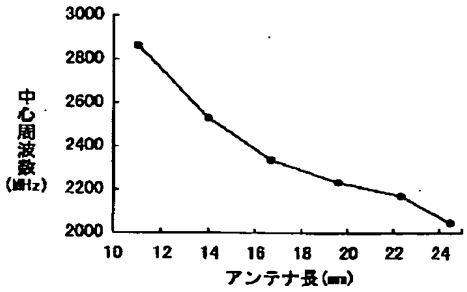
[Drawing 5]

FIG. 5



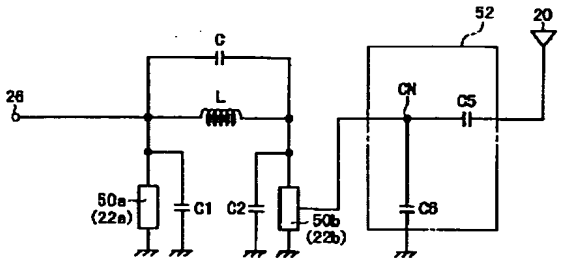
[Drawing 6]

FIG. 6



[Drawing 12]

FIG. 12



[Drawing 14]

FIG. 14A

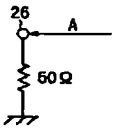
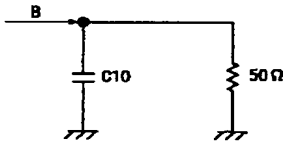
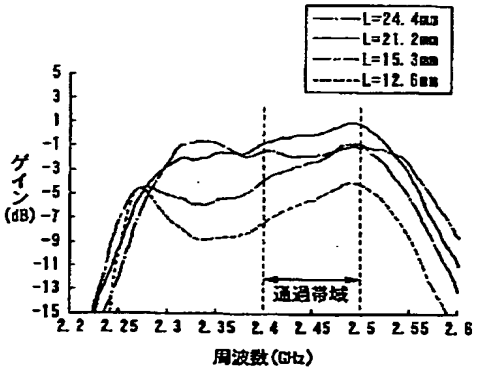


FIG. 14B



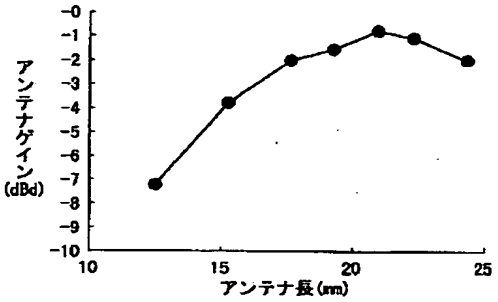
[Drawing 7]

FIG. 7



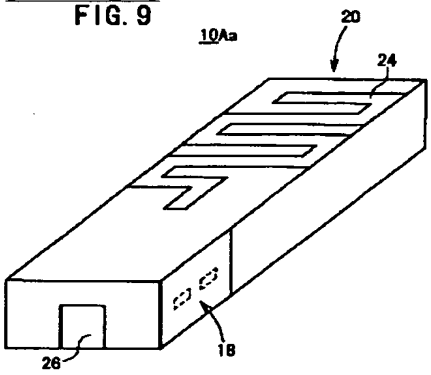
[Drawing 8]

FIG. 8



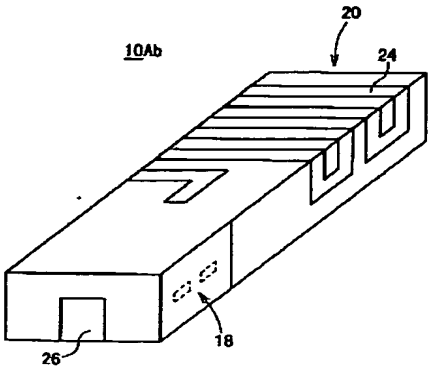
[Drawing 9]

FIG. 9



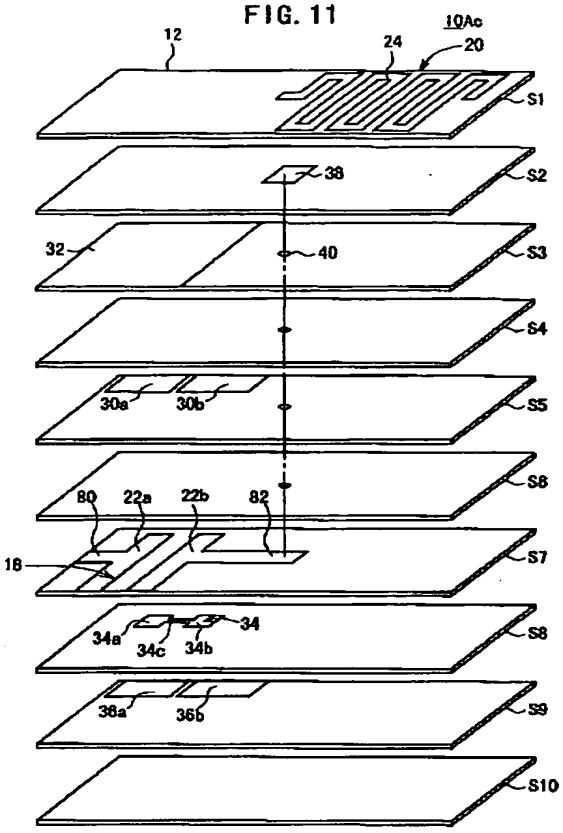
[Drawing 10]

FIG. 10



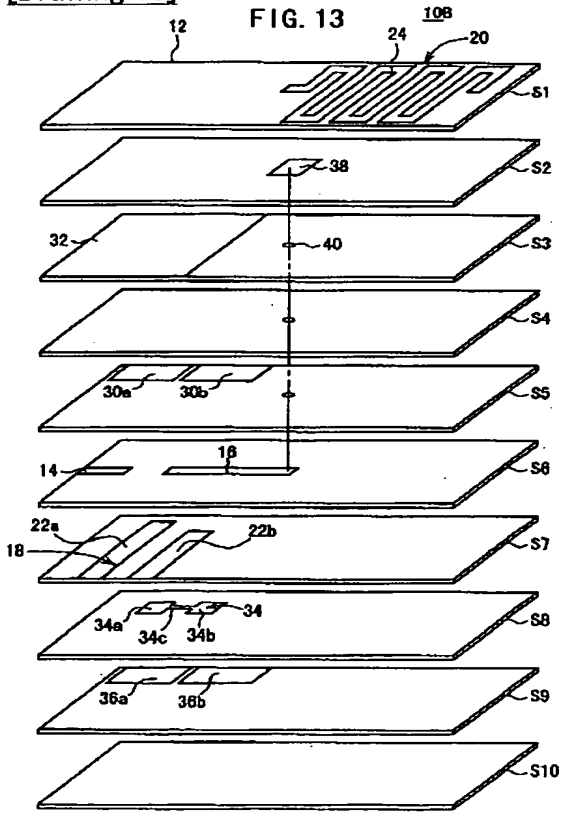
[Drawing 11]

FIG. 11



[Drawing 13]

FIG. 13



[Translation done.]